Observations on the Biology of the Lousefish, *Phtheirichthys lineatus* (Menzies)

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THE LOUSEFISH, *Phtheirichthys lineatus* (Menzies), is a slender member of the Echeneidae which is often free-swimming but which also attaches to immotile objects or slow-swimming fishes. It is pantropical, uncommon, and little known biologically.

This paper reports on 24 lousefish in the collections of the Bureau of Commercial Fisheries Biological Laboratory in Honolulu. Capture data for these specimens are presented in Table 1. Most of the other data were derived from preserved fish with the exception of one 256-mm specimen which was maintained alive in a swimming pool for several weeks.

Mr. Richard D. Samuels and Mr. Richard N. Uchida captured the fish, Mr. Everet C. Jones identified many of the food items, and Mr. Tamotsu Nakata prepared the figure. All are employees of the Bureau of Commercial Fisheries Biological Laboratory, Honolulu.

COMMON NAME

The American Fisheries Society (1960:48) lists the common name of *Phtheirichthys lineatus* as "slender suckerfish." *P. lineatus* is an uncommon or rare fish, however, and no one of my acquaintance applies this rather arbitrary name to it. In Honolulu, *Phtheirichthys* is usually called "lousefish," a name used earlier by Jordan (1907:680). "Lousefish" is used throughout this report.

ATTACHMENT

The data in Table 1 were grouped to reflect the various objects to which lousefish attached. Most small fish (ca. 40–130 mm standard length) came from essentially motionless objects: buoys, baits, and large dead fish hanging from the longline gear that caught them. One lousefish was attached to a living porcupinefish, *Diodon hystrix* Linnaeus, a notoriously slow swimmer. Lousefish have been reported from other slow swimmers including turtles (Menzies, 1791:187), barracuda (Jordan and Evermann, 1898:2268; Schultz, 1943:256; Smith, 1950:341), and large groupers (Smith, 1950: 341). It is difficult to accept Jordan and Evermann's statement (1898:2268) that lousefish occur on spearfishes.

Six specimens were free-swimming when collected, including the three largest ones which were attracted to a submerged light at night. One of the latter was kept alive in the ship's baitwell for 10 days, during which time it was occasionally seen to attach to the tank walls for 1 or 2 seconds at a time. Later it was transferred to a circular plastic swimming pool, 23 ft in diameter and 4 ft deep, which was supplied with running salt water. Here its attaching and other behavior were observed for two 1-hr periods each day for 25 days.

The captive lousefish attached only under two conditions: when I entered the pool or when it had been fed to satiety. It was necessary to clean the pool's windows and drain-strainers every few days; when I entered the water to do this work, the fish abruptly ceased swimming and attached to the pool's bottom or side. It usually remained attached for a few minutes and then darted toward me, especially if I was swimming. When I swam, it accompanied me around the pool, staying about 1 ft from my bare feet, but making no effort to attach to me.

The lousefish was fed once or twice a day. Feeding was avid to the point of greediness, the satiated fish having a bulging belly and cheeks, and usually being unable to close its mouth. In this state its swimming movements appeared to be hampered. It sank to the pool's bottom and did one of three things: either it swam slowly back and forth with a great deal

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TABLE 1

CAPTURE DATA FOR *Phtheirichthys lineatus*

DATE	LATITUDE	LONGITUDE	SEX*	STANDARD LENGTH (mm)	HOST OR HABIT
2/ 1/57	13°44′ S	110°02′ W	?	55.7	dip-netted beneath night-light
10/ 5/62	19°12′ N	156°05′ W	–	256	dip-netted beneath night-light
10/ 5/62	19°12′ N	156°05′ W	M	273	dip-netted beneath night-light
9/29/51	21°24′ N	158°15′ W	F	300	dip-netted beneath night-light
10/30/58	04°58′ S	149°52′ W	?	32.8	caught by British Columbia trawl
11/ 1/58	05°00′ S	149°58′ W	?	48.4	caught by British Columbia trawl
8/28/56	11°23′ S	134°32′ W	?	46.0	in *Thunnus albacares* stomach
7/18/50	03°00′ S	171°22′ W	?	53.0	attached to longline buoy
7/20/60	11°30′ N	161°21′ E	?	53.2	attached to longline buoy
8/26/56	13°26′ S	132°16′ W	?	54.0	attached to longline buoy
7/18/50	03°00′ S	171°22′ W	?	56.1	attached to longline buoy
2/ 7/63	17°57′ N	149°39′ W	?	51.3	attached to longline bait (squid)
2/23/63	20°41′ N	150°06′ W	?	55.5	attached to longline bait (squid)
2/ 7/63	17°57′ N	149°39′ W	?	58.9	attached to longline bait (squid)
7/31/63	21°24′ N	149°51′ W	?	61.6	attached to longline bait (squid)
2/ 6/63	18°16′ N	149°46′ W	?	92.4	attached to longline bait (squid)
8/27/56	12°16′ S	133°20′ W	?	44.0	attached to longline bait (fish)
7/24/63	14°22′ N	149°58′ W	–	81.3	attached to longline bait (fish)
7/10/63	14°24′ N	150°11′ W	–	112	attached to longline bait (fish)
5/ 5/62	02°09′ N	157°13′ W	?	48.9	attached to dead *Thunnus albacares*
2/ 6/63	18°16′ N	149°46′ W	F	126	attached to dead *Coryphaena equiselis*
8/29/62	Kahana Bay, Oahu		?	59.6	attached to living *Diodon hystrix*
7/18/50	03°00′ S	171°22′ W	?	48.6	unknown
3/15/59	14°49′ N	150°12′ W	?	60.2	unknown

* (?) = sex could not be determined; (—) = specimen not dissected.

of lateral wriggling, or it rested on the bottom with its belly down, or it attached to the pool's bottom or side. Each of these activities lasted as long as 15–20 minutes and appeared to represent a post-gorging rest. Sometimes the stuffed fish would regurgitate part of its meal and revert to swimming. Although bottom-resting was the most common post-feeding act, it is unlikely that this could happen in nature because substrates suitable for resting would not be available. If satiation resulted in such a temporary weight gain or such a loss of swimming mobility that a resting place was necessary, it is probable that a wild fish would never venture far from its attachment site. It is also probable that full meals are rare in the wild.

The lousefish made no use of its fins when resting on the bottom or attached. The large caudal was collapsed about its long central rays, the dorsal and anal were folded against the body, the pelvics were depressed, and the pectorals were semiflexed.

SWIMMING

Except for the situations noted above, the captive lousefish swam constantly in either of two patterns. More commonly it swam back and forth across the pool, passing near the center each time. In a round trip, one passage was at the pool's mid-depth (2 ft) and the return just above the bottom (4-ft depth). On the mid-depth trip the fish's attitude was normal (disk up); on the bottom trip it was inverted (disk down). During the short vertical connecting trips, the disk faced the tank walls. The fish oriented to the walls or bottom when 6–12 inches from them. Less commonly it circuited the pool's periphery on its side, with the disk facing the pool wall.

Some differences in swimming method were noted within these patterns. When the fish was swimming with the disk up, the head was essentially horizontal, the body axis hung about 8° below the horizontal, and the pectorals were

well extended. When it swam inverted, the head was again horizontal and the trunk axis dipped about 8° below the horizontal, but the caudal fin touched the pool bottom and the pectoral fins were folded. When it swam on its side along the wall, the pectorals were half folded but the caudal did not touch the wall. The inverted fish kept its head about 1½ inches above the bottom, but when swimming on its side 2 or 3 inches separated the head and the wall.

In most swimming the caudal fin was well expanded to a rhomboidal or oval shape, the pelvics were folded, and the dorsal and anal fins were only partly erect. The fish's sinuousity was impressive, as it could execute 180° turns in a circle about 6 inches in diameter. The pectorals and sometimes the pelvics were erected when the fish changed course or its plane of swimming, and also when it had just been fed to satiation. In addition, the gorged fish occasionally swam at an angle of 15° to 35° from the horizontal.

Swimming speeds were calculated for each of the three swimming attitudes and for the hungry and fed fish. Data were obtained by timing the fish as it swam between reference points on the pool's sides. Speed data are given in Table 2. In contrast to normal and inverted swimming, side-swimming when satiated was observed only once. The values given are the extremes of a number of readings. The loss of speed after feeding was marked but of short duration. Unfortunately, the only data showing this change relate to tail-beat frequency, not to speed. Tail beats were counted at 66/minute immediately after feeding, but suddenly increased to 78 and 84 beats/minute 11 minutes later.

TABLE 2

SWIMMING SPEED FOR THE LOUSEFISH

STATE OF FISH	SWIMMING ATTITUDE	RANGE IN SWIMMING SPEED (ft/sec)
Not fed for 7–12 hr	normal	1.61–2.05
	inverted	1.88–2.04
	on side	1.41–2.21
Fed to satiety	normal	0.80–1.61
	inverted	0.87–1.32
	on side	1.15–1.39

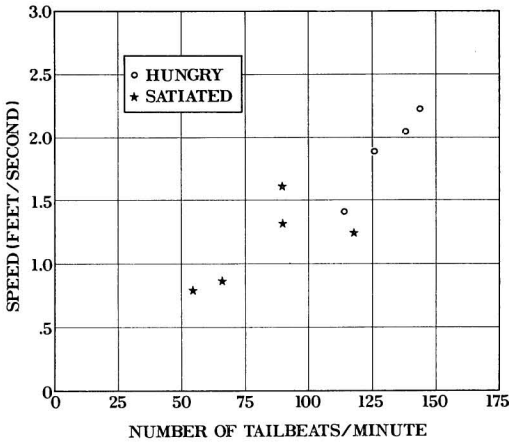

FIG. 1. Speed versus tail-beat frequency in the lousefish.

Figure 1 shows the relation between speed and tail-beat frequency. Speed and tail-beat data were obtained simultaneously as the fish transited the pool. The number of beats per minute ranged from 48 to 144. No speed estimate was obtained for the 48-beat value, which occurred 2 minutes after gorging and 1 minute before the fish sat on the bottom.

RESPIRATION

While the lousefish was swimming, its mouth was always open and no opercular movements were detectable. In this respect it resembled *Remora remora* (Linnaeus), which ceased opercular pumping under conditions of optimum, if artificial, water flow over the gills (Strasburg, 1957). The speed range (or the flow rate) observed for the hungry lousefish (1.41–2.21 ft/sec), however, was more than twice the range (0.75–0.88 ft/sec) judged optimal for *R. remora* (Strasburg, 1957).

When gorged, the lousefish usually sat on the bottom or attached. Its mouth remained open and opercular respiratory movements were conspicuous. The well-developed tongue was alternately pressed to the mouth's roof and returned to its bed, in a rhythm keyed to the opercular movements. Sometimes the fish oriented to face the weak current at the pool's inlet. The number of respirations per minute ranged from 84 to 120—a much lower range than for *R. remora*, which had from 203 to 244 respirations per

minute when attached but unfed (Strasburg, 1957). Stuffing the digestive tract with food possibly inhibits the respiratory rate on some mechanical basis. Once when the lousefish fed until it bulged, and then attached to the bottom, it had a rate of 84 respirations per minute. Six minutes later, when it regurgitated four cubes of shark flesh, the rate increased to 114 respirations per minute.

FOOD AND FEEDING

The results of stomach analyses of four lousefish were presented in an earlier paper (Strasburg, 1959:246). It has since been possible to examine 16 more stomachs and obtain better definition of the scope of the diet, and also to observe the feeding behavior of a living specimen.

Of the 20 lousefish stomachs examined 2 were empty. The balance contained mostly planktonic crustaceans, especially small and larval forms. The crustaceans and the number of stomachs in which they occurred were as follows: hyperiid amphipods (1), unidentified amphipods (6), crab larvae (2), unidentified decapod larvae (1), stomatopod larvae (2), Euphausiacea (1), Mysidacea (1), Ostracoda (3), unidentified crustacean fragments (3), and the following copepods: *Candacia pachydactyla* (5), *C. aethiopica* (2), *Candacia* sp. (1), *Scolecithrix danae* (1), *Euchaeta* sp. (3), unidentified calanoids (3), *Sapphirina* sp. (1), *Oncaea* sp. (1), and unidentified cyclopoids (1). Also, 2 stomachs contained fish flesh and bones, and 2 had small flakes of rusty iron.

None of the food species is parasitic, and it is thus unlikely that the lousefish is a cleaner, in contrast to most other echeneids (Szidat and Nani, 1951:413; Maul, 1956:14; Strasburg, 1959:246). Instead, it appears to feed rather selectively on planktonic animals, especially on such conspicuous creatures as the black-and-white copepods *Candacia pachydactyla* and *C. aethiopica,* the iridescent blue copepod *Sapphirina,* and large stomatopod larvae. Rust flakes from the fishing vessel probably were ingested because they were relatively conspicuous. Mysids had been eaten only by the 59.6-mm lousefish attached to a living *Diodon hystrix* caught in Kahana Bay, Oahu. Mysids abound in this shallow bay, and the fish had gorged on 41 of them.

The captive lousefish was fed small cubes of bread, shrimp, or shark flesh once or twice a day. Presentation of food was preceded by a cue (described below) and continued until the offerings were ignored. The fish reacted to food particles from a distance of about 3 ft; the water was very clear. It refused particles lying on the bottom, and preferred to feed on sinking food pieces near the surface. Pieces less than about 3 mm in greatest dimension were ignored in favor of larger ones (up to about 1 cm in greatest dimension). The 3-millimeter pieces were "inhaled" without noticeable jaw movements, whereas those in the 7- to 10-mm range were gulped with conspicuous jaw action. As noted earlier, the fish was a greedy feeder and ate until its belly and cheeks bulged. A full meal required 3 or 4 minutes to consume. When fed once a day for 3 successive days, the volume of shark flesh eaten per meal was 5.1, 5.0, and 2.6 cc. On the last day the fish also ate bread crumbs whose volume had not been measured.

The lousefish was accidentally placed in the wrong pool at first, and for a time I planned to recapture it by dip net for transfer elsewhere. It was necessary to condition the fish to the dip net, for its earlier capture had made it wary. A dip net was placed in the pool before each feeding, and food was offered over the net so that the fish had to swim above the meshes to feed. On the third day of this procedure (the fifth feeding) the fish swam slowly but directly to the net when it was placed in the pool. At the next feeding it dashed immediately to the net, and continued to do so whenever the net was shown. Because it proved unnecessary to transfer the fish, this conditioning went for nought. The fish was subsequently trained to come to the feeding area when the water's surface was slapped with the hand.

COLOR AND COLOR CHANGE

A description of the life colors of the lousefish could not be found in the literature and is therefore presented here. In sunlight the dorsal surfaces of the head and body are navy blue and the ventral surfaces are white. In shade the

navy blue often appears as velvety black. Separating these contrasting colors are three lengthwise stripes along the sides. The upper stripe is narrow and light blue, the middle is broad and black, and the lower is narrow and silvery white. The light-blue stripe commences on the upper snout (where it meets its fellow), touches the upper edge of the eye, and continues thence to the caudal base. The black stripe runs from the snout through the eye to the caudal base, and expands on the caudal fin so that the fin is black except for narrow white dorsal and ventral margins. The silvery-white stripe runs from the rictus to the lower edge of the eye and thence along the lower mid-side to the caudal base. The dorsal and anal fins are black basally and margined with white anteriorly. The pectorals and pelvics are plain blackish.

This color was characteristic of the captive lousefish during its first 7 days in the swimming pool. Thenceforth its ventral surface gradually darkened, changing from white to gray-spotted (eighth day) to uniform gray (ninth day) to gray-black (tenth day). Subsequently the color of its undersides fluctuated between gray, deep slate blue, and black, there being no apparent relation between color and incident light or fish activity. Frequently, however, the color of the undersides was lighter just after feeding. Sometimes the back and the base of the dorsal and anal fins were the same color as the undersides. The three lateral stripes were unvaryingly the same. By the twenty-first day the fish's dorsal and ventral surfaces were both jet black, and no further changes were observed. When the fish was preserved after 25 days, it retained its melanistic coloration in alcohol.

During the lousefish's 25-day confinement, the color of the pool walls changed markedly as the diatom *Melosira* proliferated from essentially nothing to a growth 2 inches thick. The fish's gradual color change paralleled this growth. The darkening may have been caused by a general increase in the amount of melanin. On the other hand, a faculty for rapid color change has been reported for *Echeneis naucrates* (Beebe and Tee-Van, 1933:222; Nichols *in* LaGorce, 1939:163; Sanborn, 1932:89; Townsend, 1927:171) and for *Remora remora* (Maul, 1956:50, 66), and thus it is possible that the observed changes were highly transitory.

Another explanation for this color change derives from observations on echeneids which regularly attach. These fish have been stated either to lack countershading (Cott, 1940:43; Pincher, 1948:283) or to have reversed countershading (Norman and Fraser, 1949:176). A lack of countershading supposedly results from a failure to maintain constant orientation to a light source; a reversal of countershading arises from the fact that the echeneid's belly is usually more brightly illuminated than its back. The first explanation possibly fits the color change described above for the lousefish. When captured it had normal countershading, but began to lose it after a period in which swimming was often inverted or on the side. When free in the pelagic environment the lousefish presumably swims in a normal attitude.

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